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[54] **ARTICLE AND A METHOD AND APPARATUS FOR PRODUCING AN ARTICLE HAVING A HIGH FRICTION SURFACE**

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| | | | |
|-----------|---------|-----------|---------|
| 2,823,562 | 2/1958 | Humbarger | 76/24.1 |
| 2,858,256 | 10/1958 | Fahnoe | 51/309 |
| 2,876,086 | 3/1959 | Raymond | 51/298 |
| 2,904,418 | 9/1959 | Fahnoe | 51/293 |
| 3,016,294 | 1/1962 | Haywood | 51/297 |
| 3,048,482 | 8/1962 | Hurst | 51/298 |
| 3,090,614 | 5/1963 | Freeman | 269/273 |
| 3,102,011 | 8/1963 | Bellinger | 51/298 |
| 3,112,163 | 11/1963 | Alderfer | 18/59 |
| 3,211,634 | 10/1965 | Lorenzo | 205/114 |
| 3,216,074 | 11/1965 | Harrison | 22/193 |
| 3,306,719 | 2/1967 | Fringhian | 428/556 |

(List continued on next page.)

Related U.S. Application Data

[60] Continuation of application No. 08/487,571, Jun. 7, 1995, abandoned, which is a division of application No. 08/287,788, Aug. 9, 1994, abandoned, which is a division of application No. 08/022,988, Feb. 26, 1993, Pat. No. 5,336,279, which is a division of application No. 07/952,682, Sep. 24, 1992, abandoned, which is a division of application No. 07/453,684, Dec. 20, 1989, Pat. No. 5,181,939.

[51] **Int. Cl.⁷** **B22F 7/04**

[52] **U.S. Cl.** **428/560; 428/552; 428/564; 428/539.5**

[58] **Field of Search** 425/3; 428/551, 428/552, 560, 564, 565, 567, 568, 539.5

[56] References Cited

U.S. PATENT DOCUMENTS

| | | | |
|------------|---------|-------------|---------|
| Re. 28,068 | 7/1974 | Lemelson | 264/24 |
| 1,788,600 | 1/1931 | Smyser | 51/295 |
| 1,854,071 | 4/1932 | Schacht | 51/295 |
| 1,930,788 | 10/1933 | Buckner | 18/5 |
| 2,001,911 | 5/1935 | Wooddell | 451/529 |
| 2,015,658 | 10/1935 | Bezenberger | 51/295 |
| 2,076,846 | 4/1937 | Johanson | 264/153 |
| 2,184,896 | 12/1939 | Oglesby | 51/295 |
| 2,198,766 | 4/1940 | Gallagher | 51/295 |
| 2,292,261 | 8/1942 | Albertson | 451/527 |
| 2,334,494 | 11/1943 | Keeleric | 428/600 |
| 2,353,404 | 7/1944 | Keeleric | 51/295 |
| 2,367,286 | 1/1945 | Keeleric | 51/309 |
| 2,370,970 | 3/1945 | Keeleric | 51/309 |
| 2,424,140 | 7/1947 | Beecher | 205/114 |
| 2,582,231 | 1/1952 | Catallo | 51/309 |
| 2,793,427 | 5/1957 | Marvin | 419/8 |
| 2,798,474 | 7/1957 | Ballhausen | 428/550 |
| 2,820,746 | 1/1958 | Keeleric | 205/114 |

FOREIGN PATENT DOCUMENTS

1505923 4/1978 United Kingdom .

Primary Examiner—Kathryn Gorgos

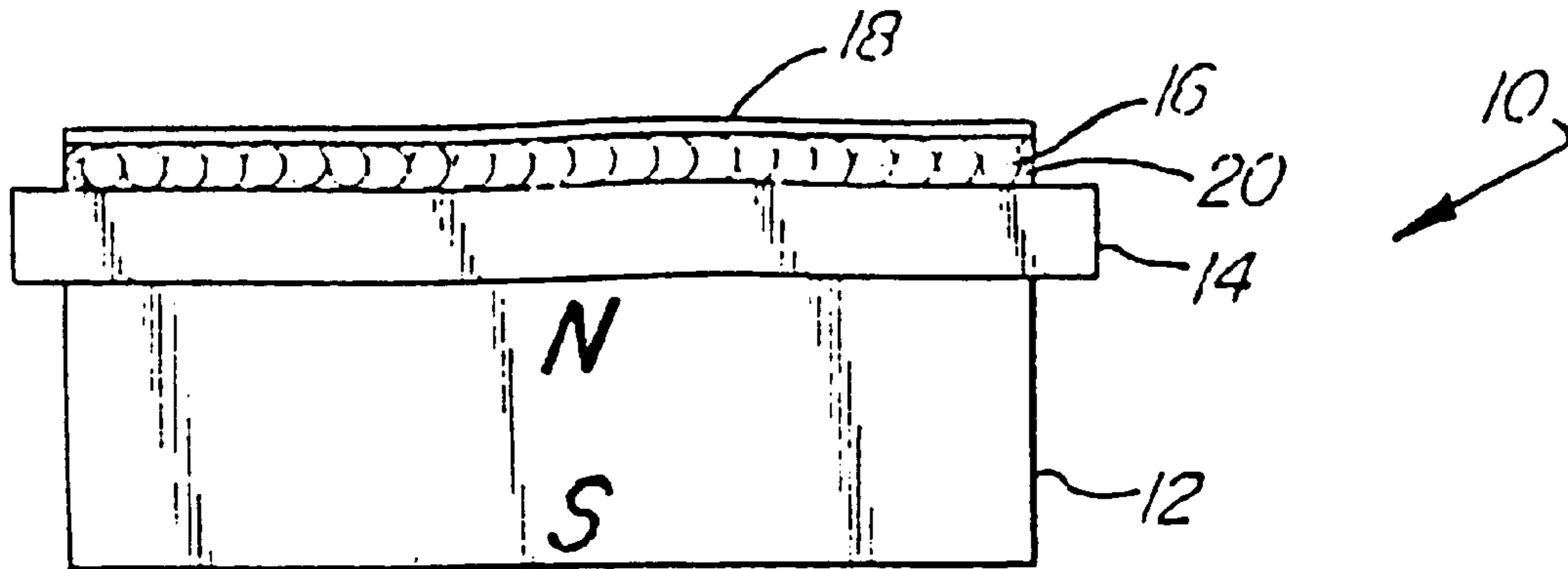
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[57] ABSTRACT

A product and a process for producing a matrix and a tool for use in abrasive or cutting applications including a base tool structure which may be armed with a plurality of triangular or conically shaped structures **24B** consisting of abrasive particles **32** bonded together in a braze metal **38**. The structures **24B** may be prepared in a manner which provides a selectable rake angle. Rake angles including negative **46**, neutral **46'** and positive **46''** may be produced. The process is accomplished by diffusing magnetizable abrasive particles on a release mechanism which has been placed on a reusable fixture **10** consisting of a plurality of balls **16** secured to a magnetized surface **14**. The particles **32** stack to form structures **24** which are then encapsulated in a braze paste **26**. The axis of the structures **24** is aligned with the applied magnetic field. The cones are symmetrical if the magnetic field emanates perpendicularly from the magnetized surface. If the orientation of the magnetic field is distorted the conical structures will realign themselves therewith. In this manner conical structures **24** may be formed which offer selectable rake angles. The matrix **22** formed by encapsulating the abrasive particles **32** may be removed from the release mechanism **18** and secured to a base structure **30**. Once this assembly has been brazed, the base structure may be used as an abrading or cutting tool.

27 Claims, 3 Drawing Sheets



| U.S. PATENT DOCUMENTS | | | | | |
|-----------------------|---------|------------------------------|-----------|---------|------------------------------|
| | | | 4,246,004 | 1/1981 | Busch 51/295 |
| | | | 4,246,316 | 1/1981 | Aonuma et al. 428/329 |
| | | | 4,288,233 | 9/1981 | Wiand 51/295 |
| | | | 4,371,590 | 2/1983 | Izumi et al. 428/555 |
| | | | 4,439,795 | 3/1984 | Kitamoto et al. 360/131 |
| | | | 4,439,796 | 3/1984 | Kitamoto et al. 360/131 |
| | | | 4,539,017 | 9/1985 | Augustin 51/293 |
| | | | 4,587,066 | 5/1986 | Rodriguez 264/22 |
| | | | 4,610,698 | 9/1986 | Eaton et al. 51/295 |
| | | | 4,643,740 | 2/1987 | Nicolson 51/293 |
| | | | 4,799,939 | 1/1989 | Bloecher 51/293 |
| | | | 4,916,869 | 4/1990 | Oliver 51/293 |
| | | | 4,920,009 | 4/1990 | Lee et al. 428/552 |
| | | | 4,977,709 | 12/1990 | Siden 451/541 |
| | | | 5,181,939 | 1/1993 | Neff 51/298 |
| 3,431,105 | 3/1969 | Heck 419/2 | | | |
| 3,504,063 | 3/1970 | Lemelson 264/24 | | | |
| 3,607,569 | 9/1971 | Greenwell 156/500 | | | |
| 3,625,666 | 12/1971 | James 51/295 | | | |
| 3,807,966 | 4/1974 | Butcher et al. 29/182.2 | | | |
| 3,840,400 | 10/1974 | Yamada et al. 117/235 | | | |
| 3,894,673 | 7/1975 | Lowder 228/124.5 | | | |
| 3,898,772 | 8/1975 | Sawluk 451/547 | | | |
| 3,918,217 | 11/1975 | Oliver 51/295 | | | |
| 3,957,939 | 5/1976 | Voaden 264/92 | | | |
| 4,010,583 | 3/1977 | Highberg 451/52 | | | |
| 4,078,906 | 3/1978 | Green 51/295 | | | |

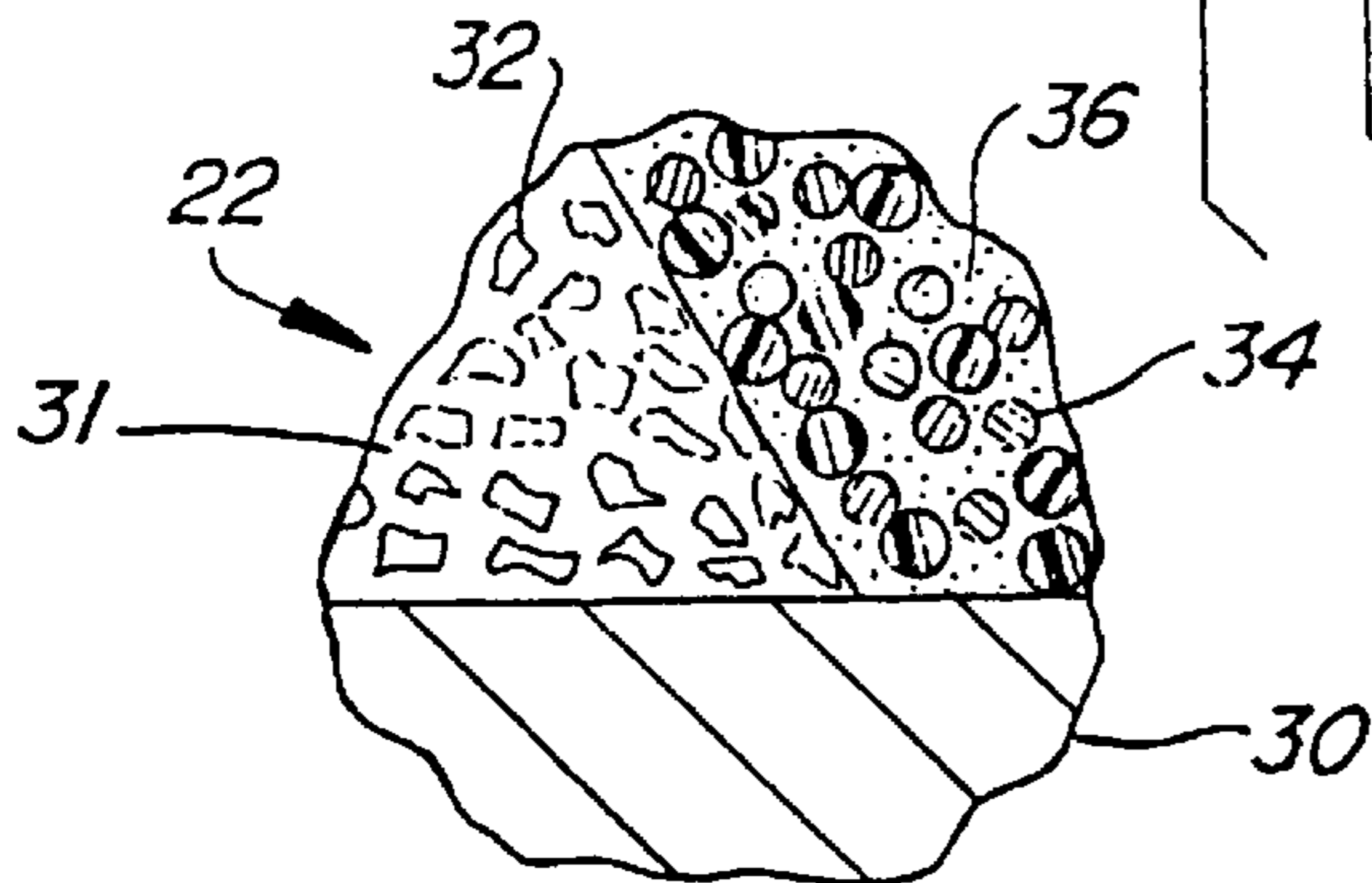
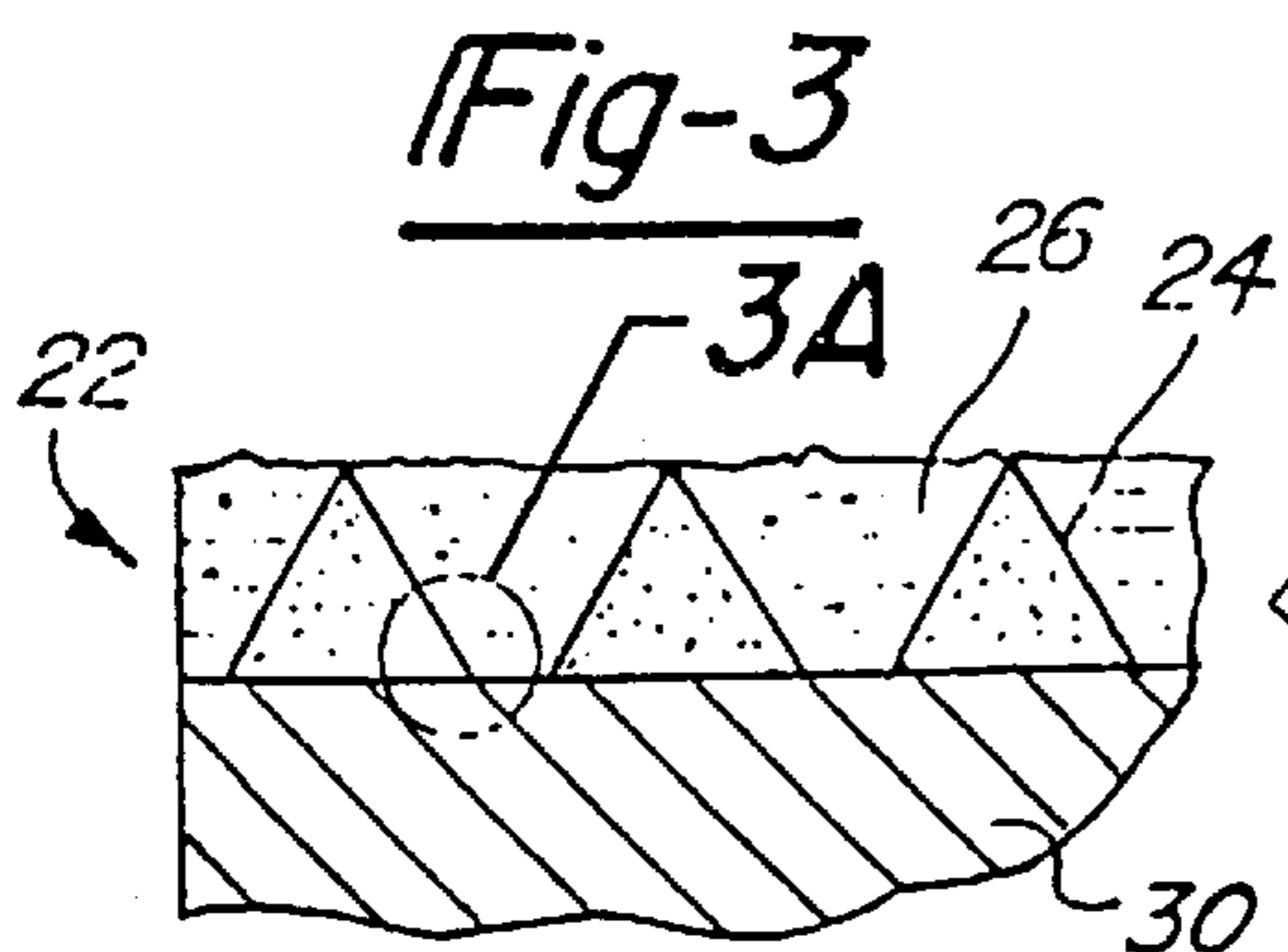
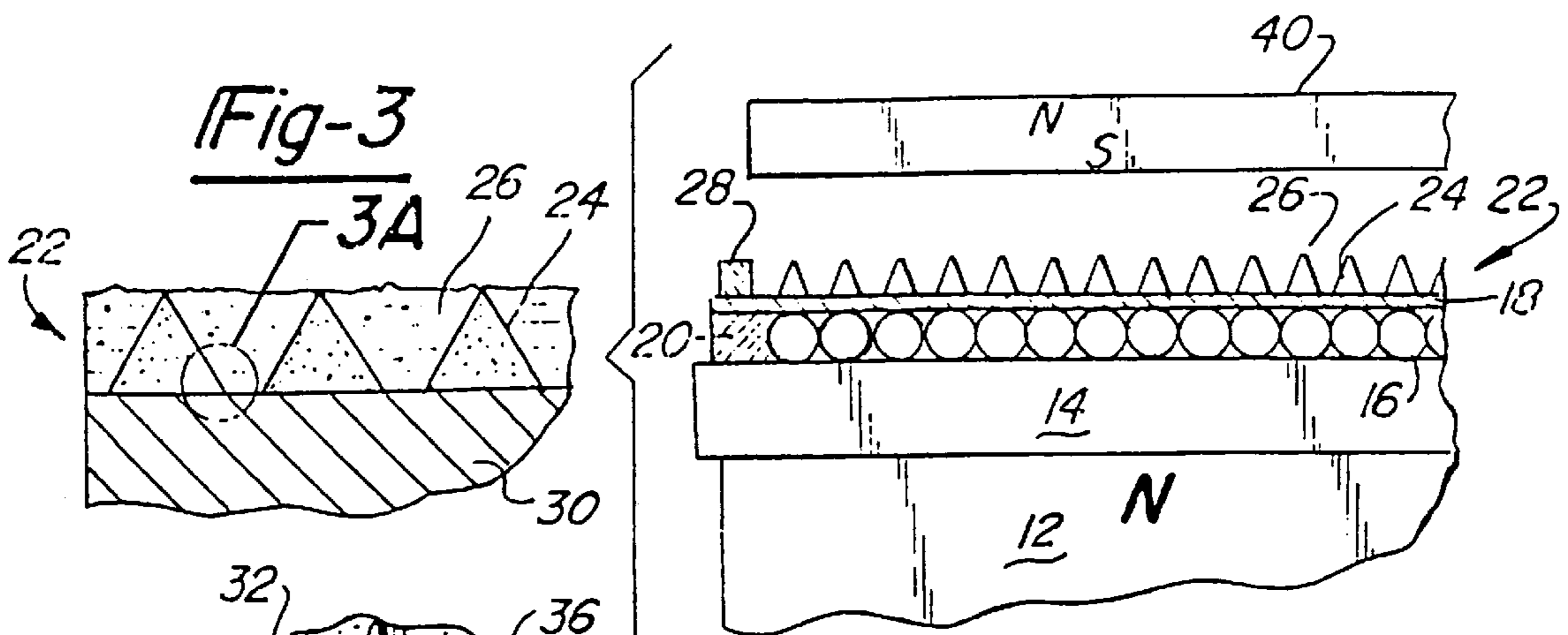
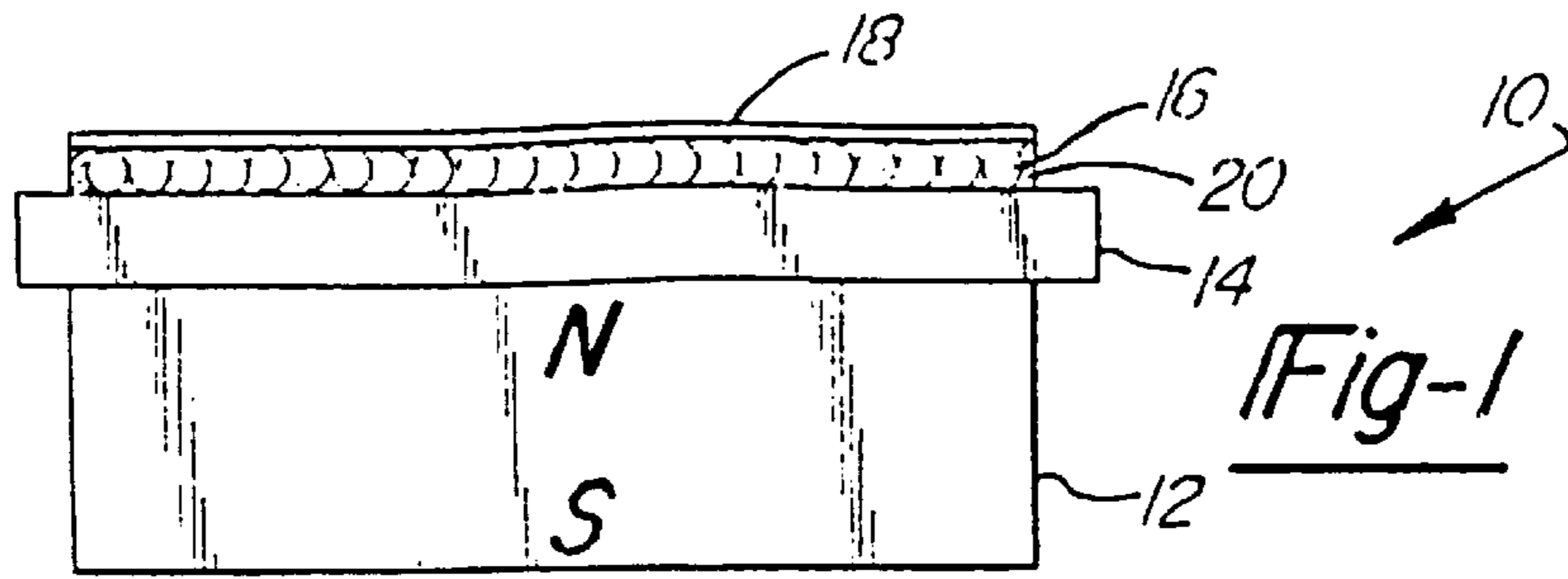


Fig-3A

Fig-2

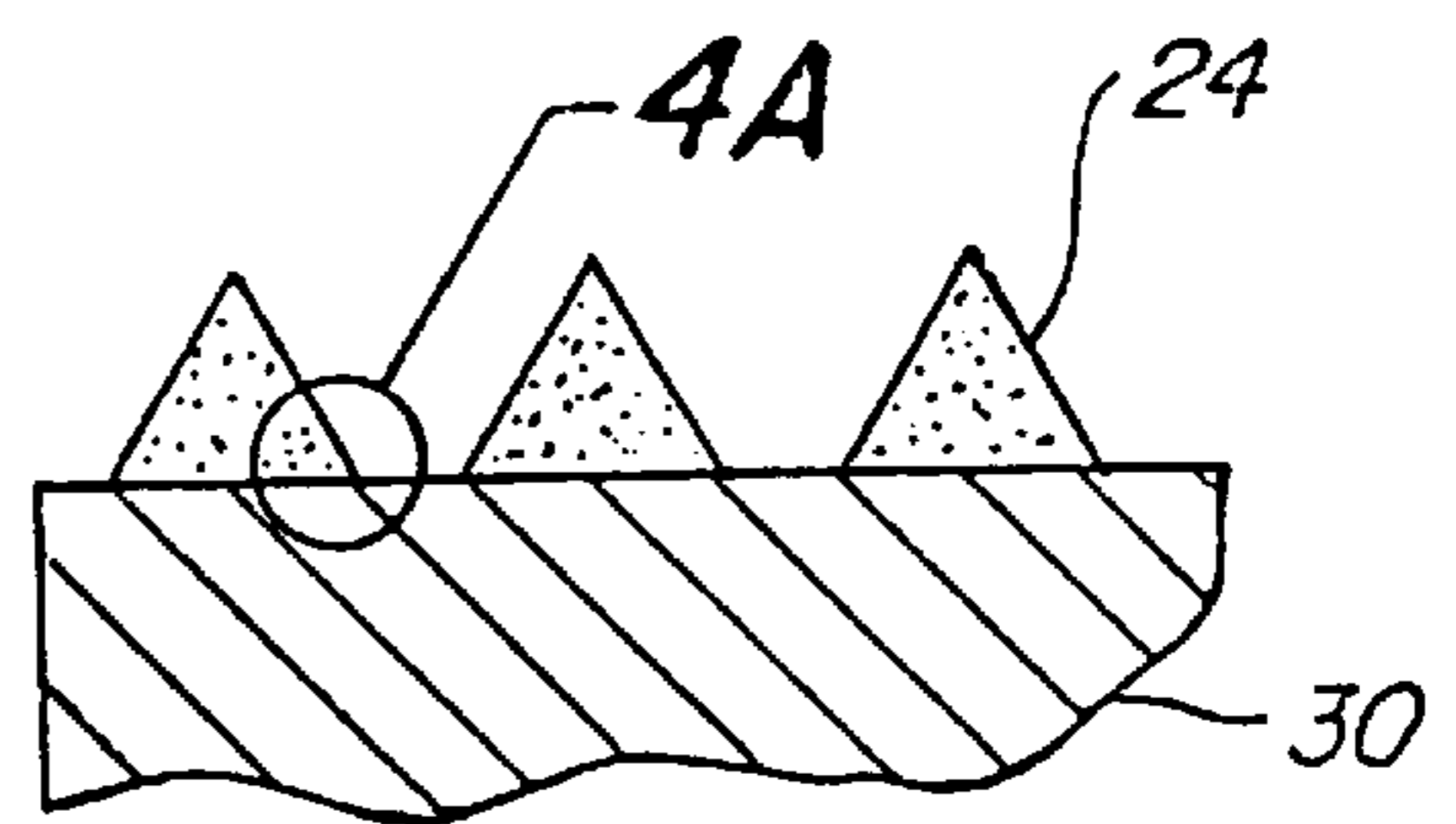


Fig-4

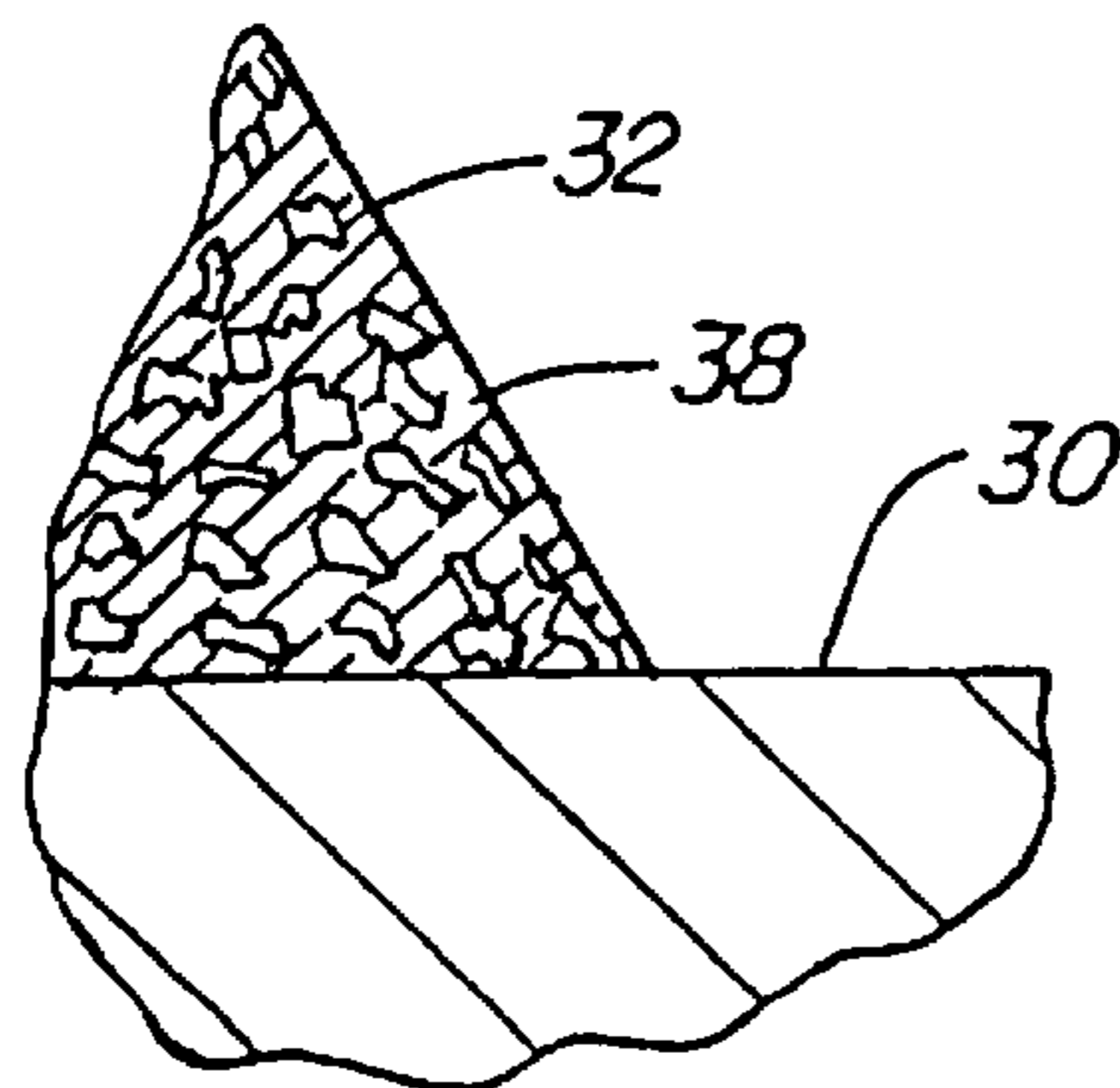


Fig-4A

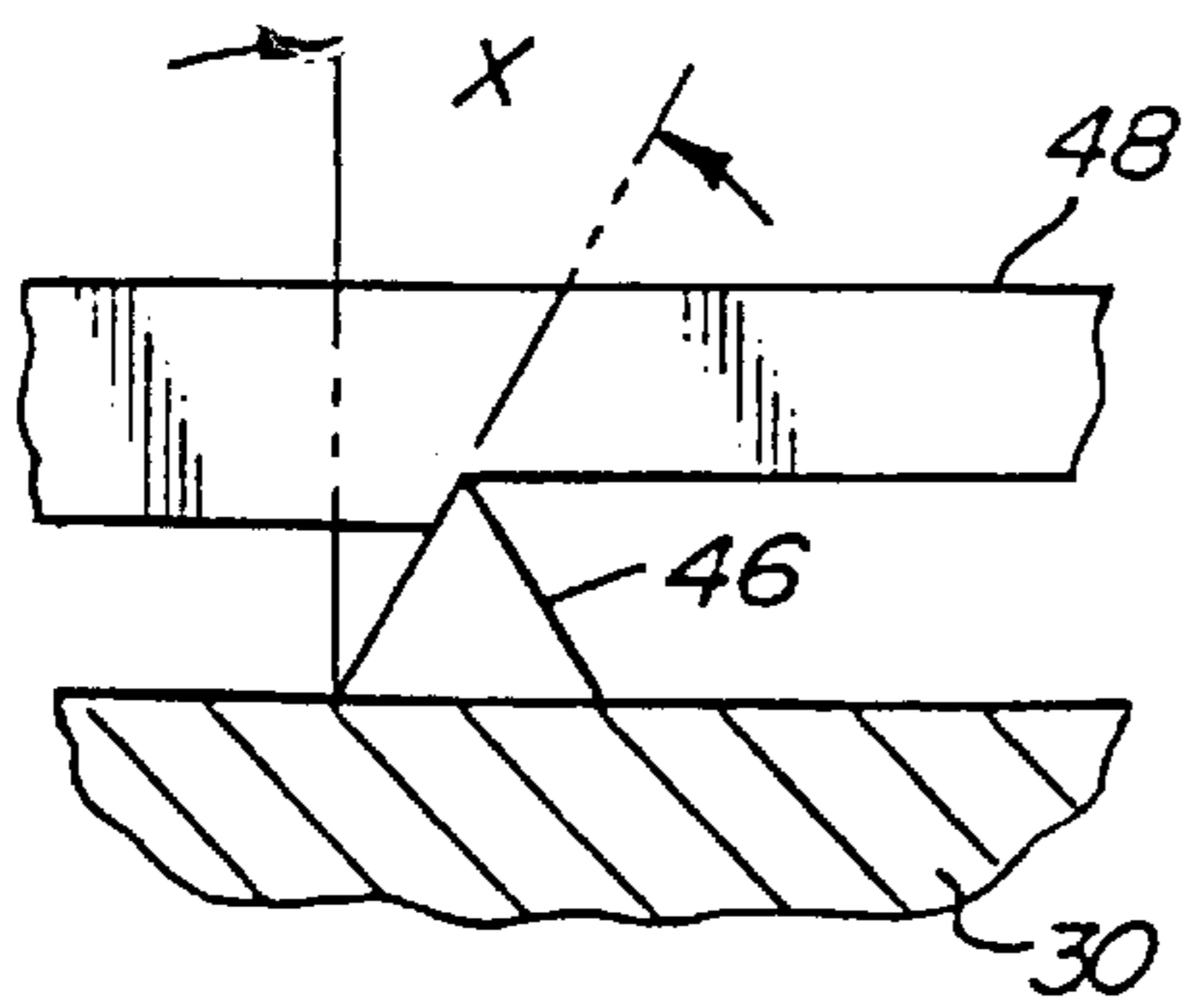


Fig-5

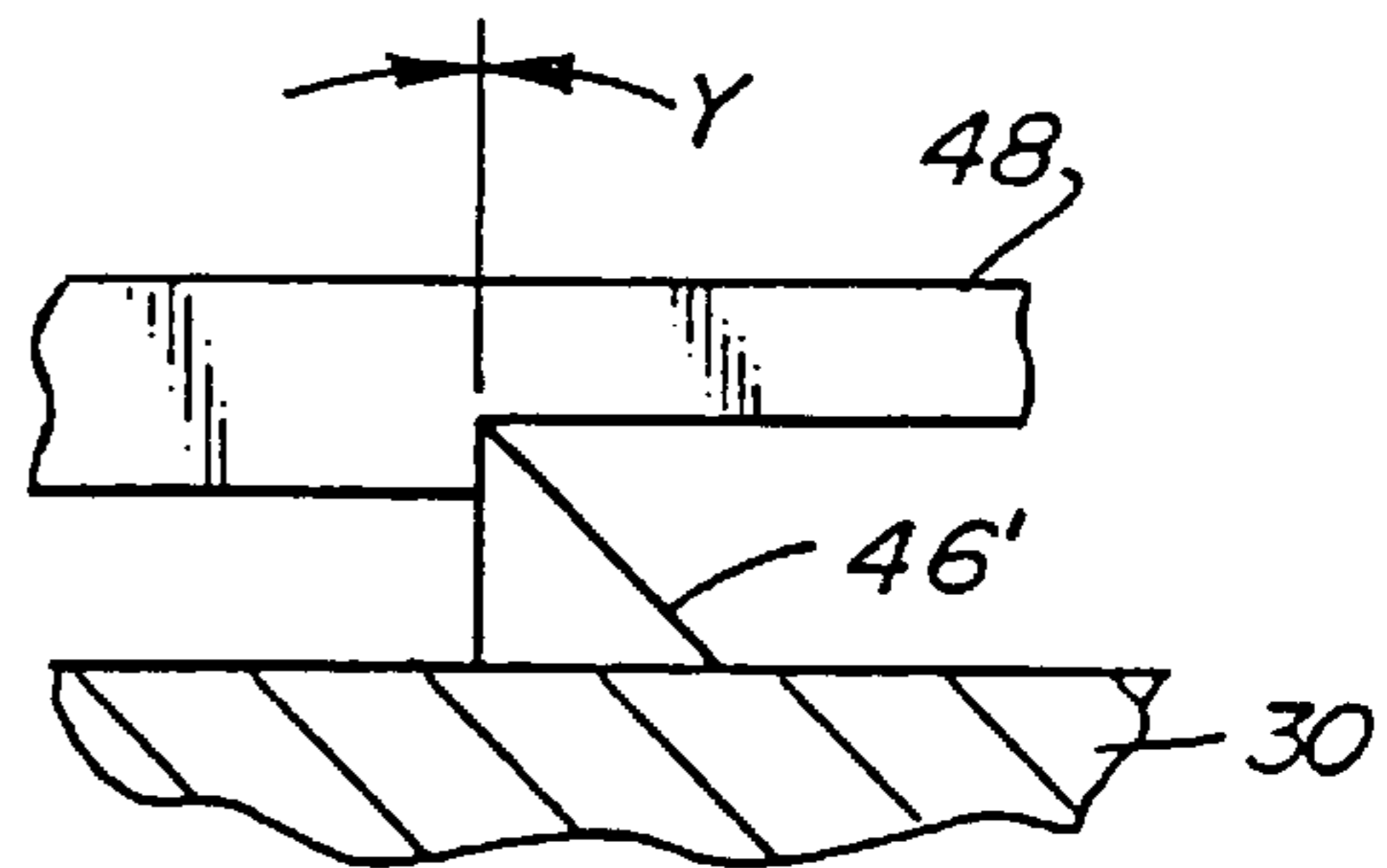


Fig-6

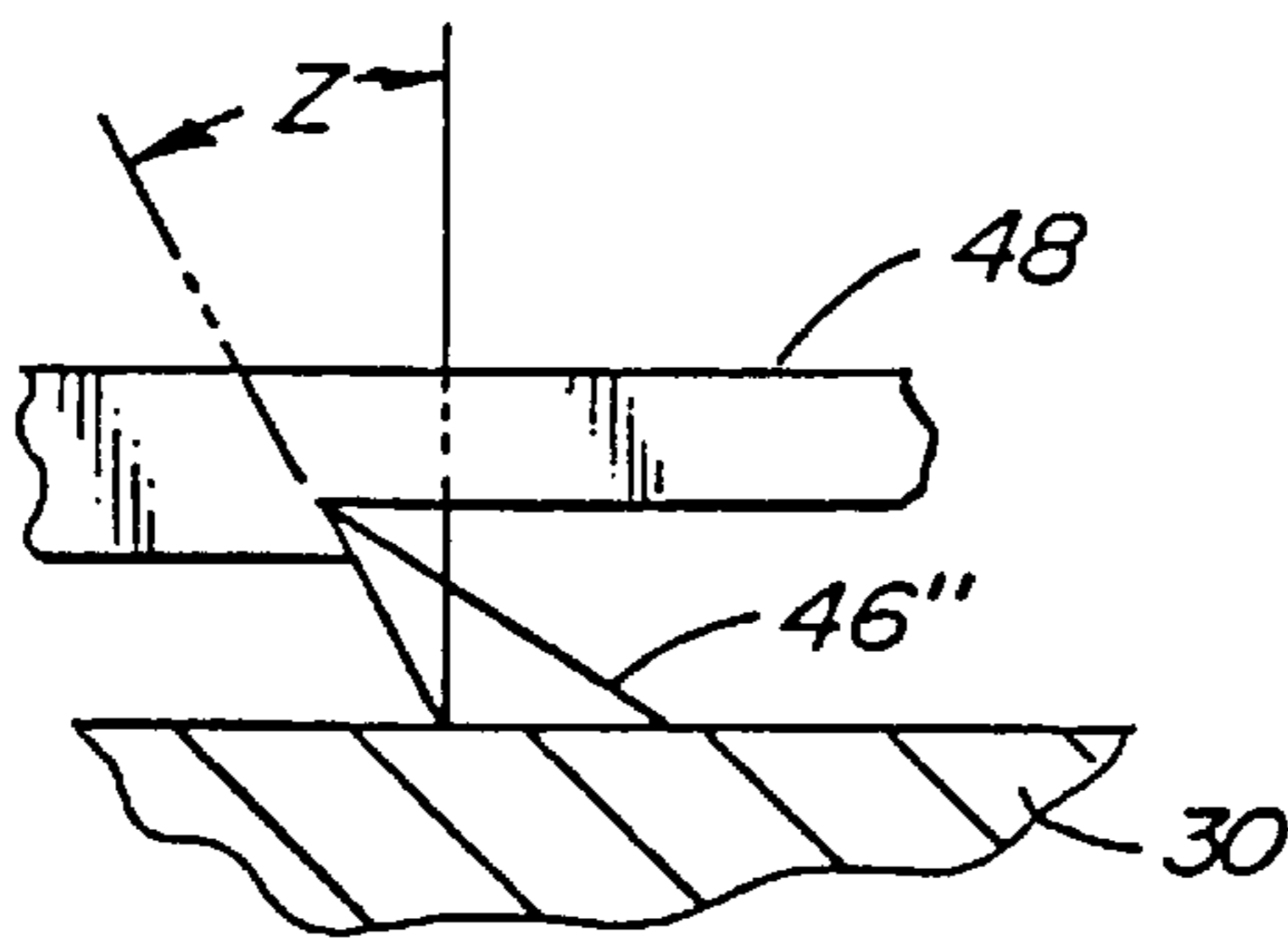


Fig-7

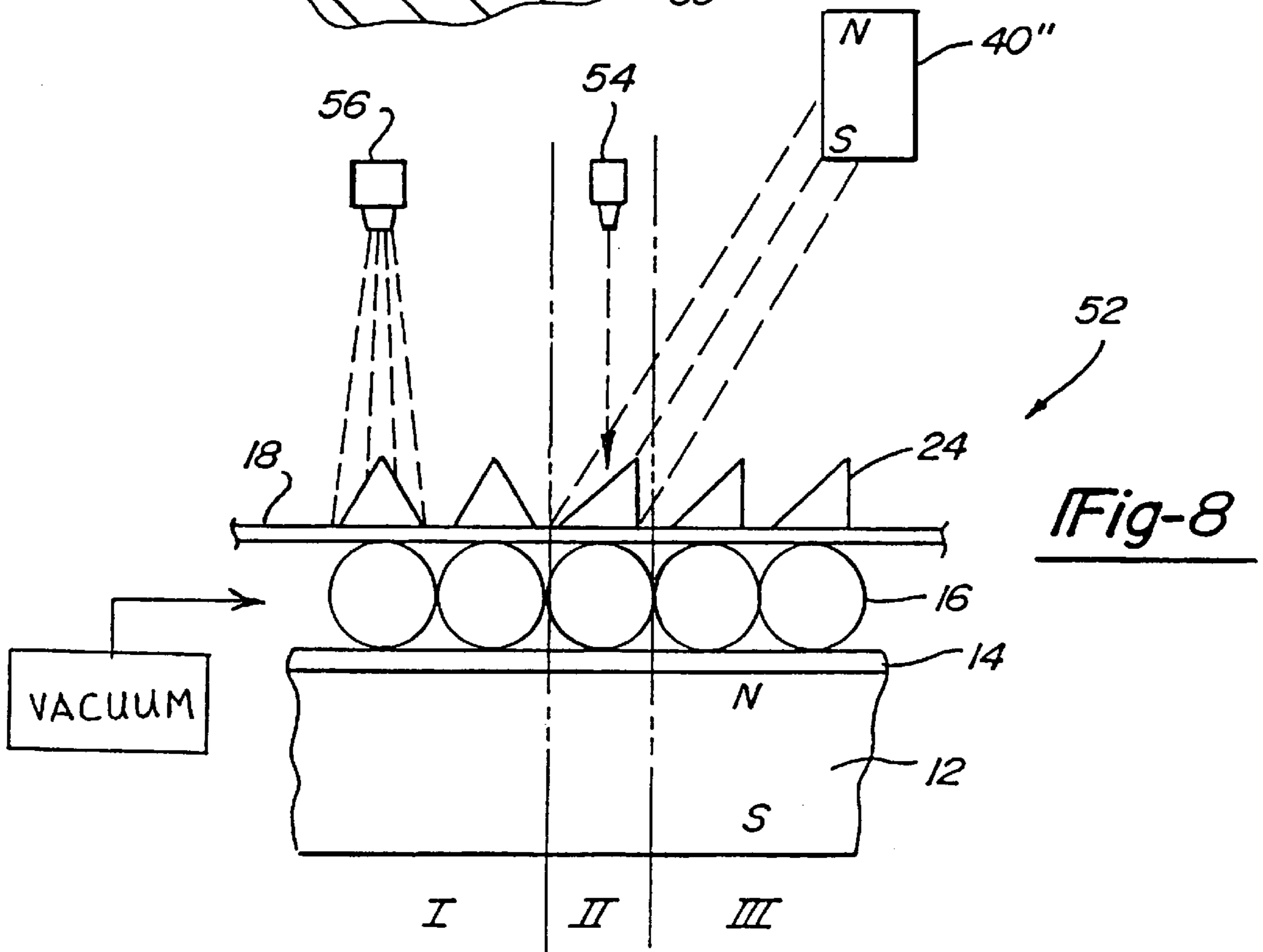
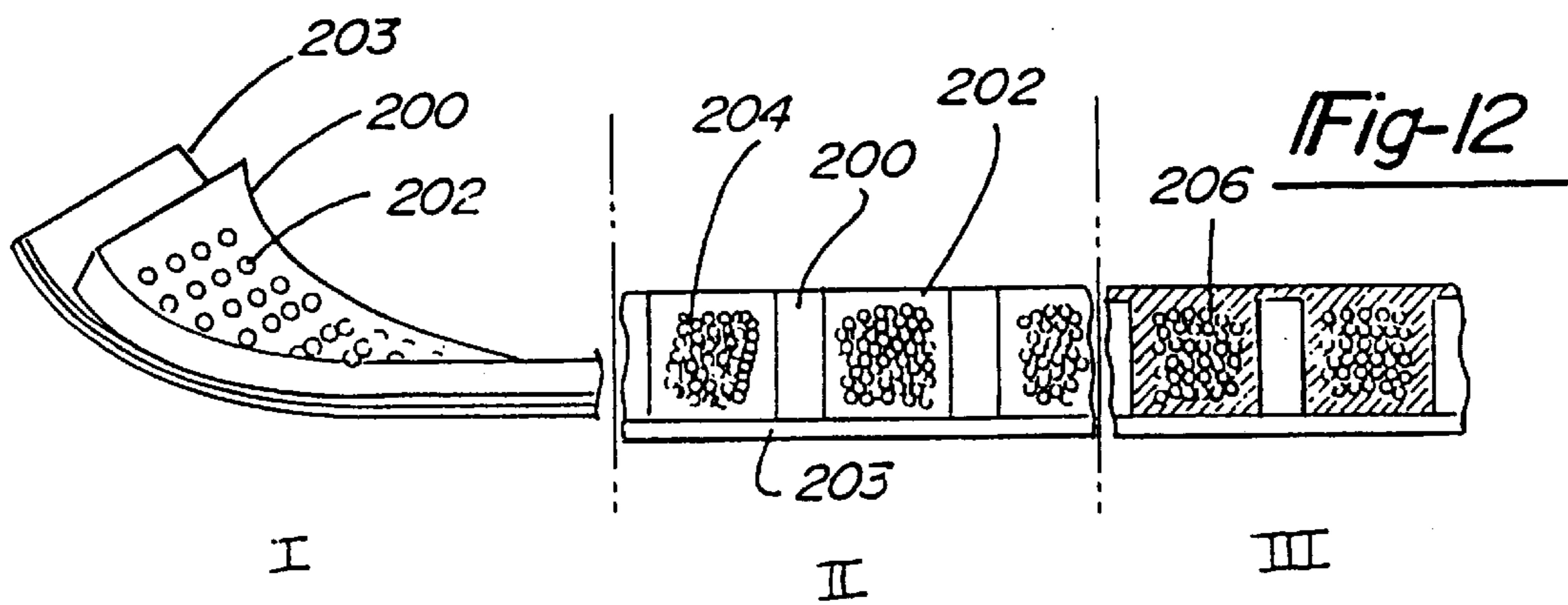
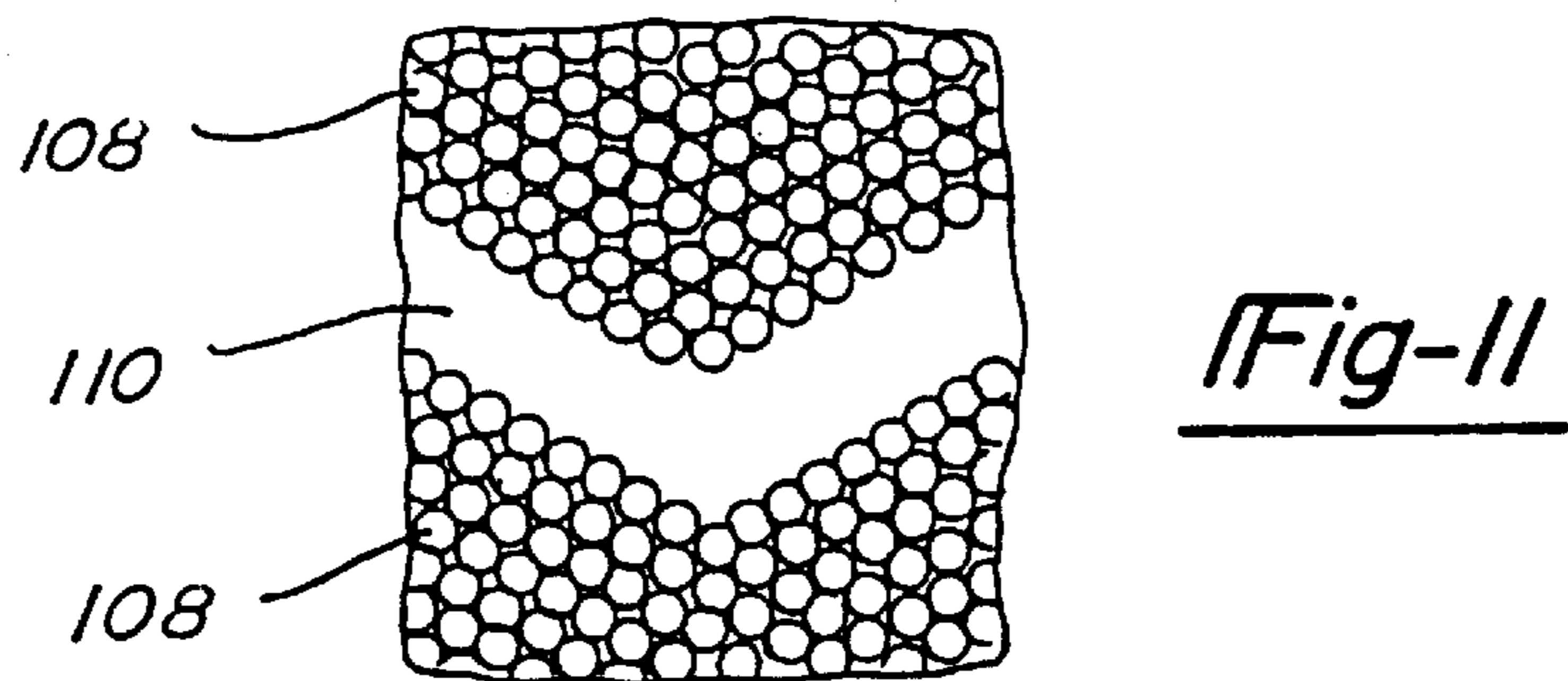
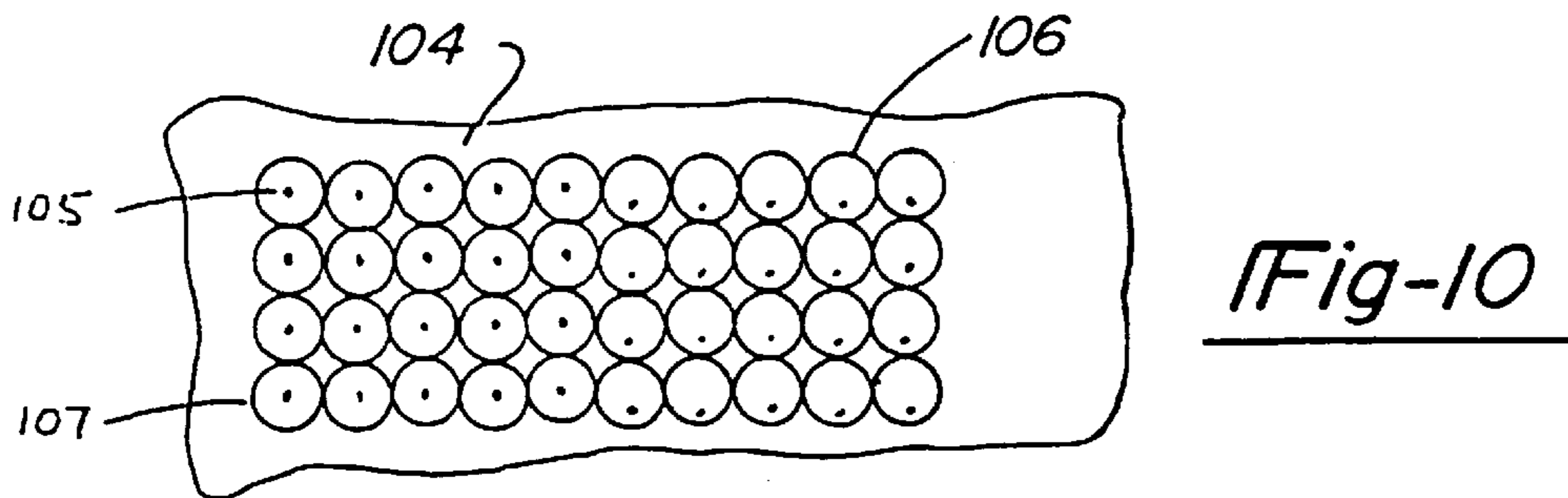
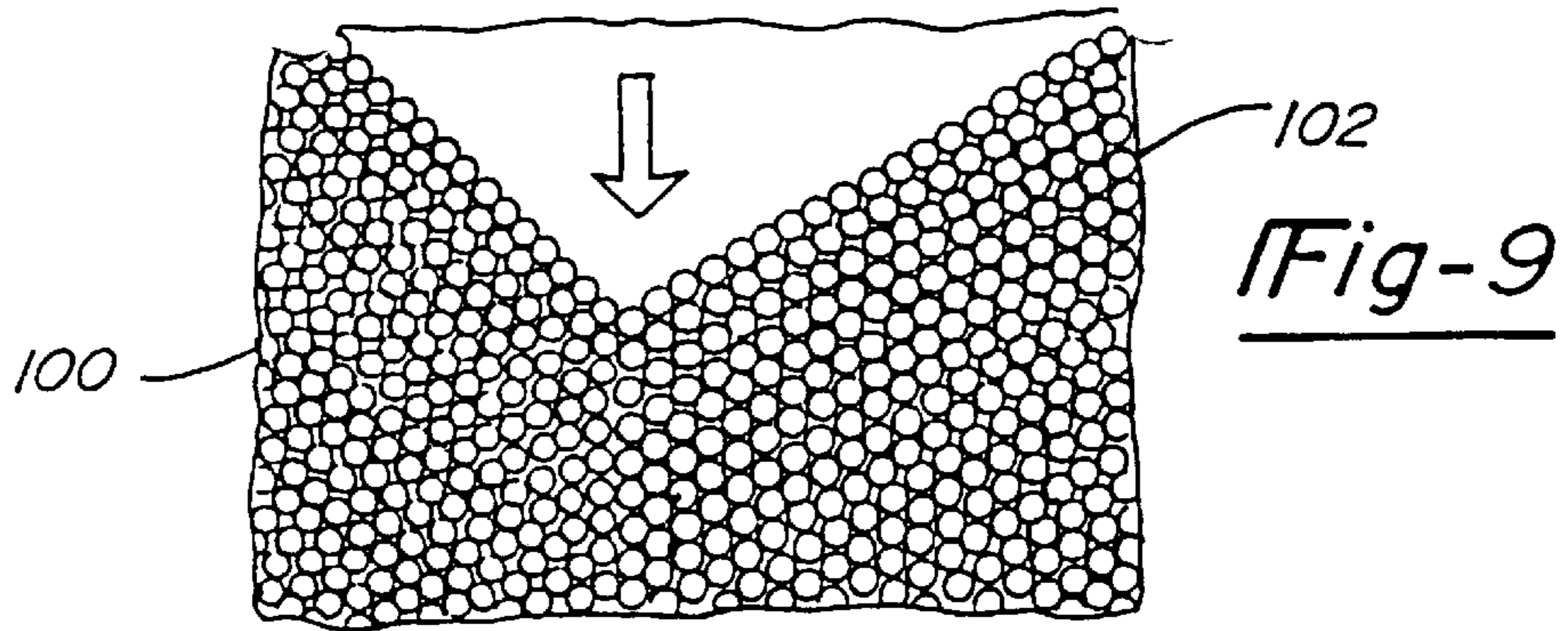


Fig-8



**ARTICLE AND A METHOD AND
APPARATUS FOR PRODUCING AN
ARTICLE HAVING A HIGH FRICTION
SURFACE**

This is a continuation of application Ser. No. 08/487,571 filed Jun. 7, 1995, now abandoned, which is a division of Ser. No. 08,287,788 filed Aug. 9, 1994, now abandoned, which is a division of Ser. No. 08/022,988 filed Feb. 26, 1993, now U.S. Pat. No. 5,336,279, which is a division of Ser. No. 07/952,682 filed Sep. 24, 1992, now abandoned, which is a division of Ser. No. 07/453,684 filed Dec. 20, 1989, now U.S. Pat. No. 5,181,939.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to high friction surfaces for use in abrasive applications and the preparation of such high friction surfaces. In particular, the present invention relates to abrasive tools prepared by use of a matrix of braze paste and abrasive particles which have been oriented in a preselected pattern.

2. Description of the Prior Art

U.S. Pat. No. 3,918,217, hereinafter referred to as Oliver, discloses an abrasive tool comprising a tool blank having small steel balls secured thereto which have been armed with magnetically oriented carbide particles. The carbide particles are secured together and to the balls by braze metal. An Oliver-type tool is typically prepared, in part, by first securing a single layer of small steel balls to the surface of a tool blank. A magnet is then secured to the tool blank below the balls. Next, magnetizable carbide particles are sprinkled onto the small steel balls. The magnetic flux concentrations produced by the flux path through the small steel balls cause the carbide particles to collect on the outermost portions of the balls to form conical structures. A braze paste consisting of a binder and a braze alloy is then applied to encapsulate all of the elements of the assembly. Finally, the entire assembly is subjected to heating in a brazing furnace which bonds the braze alloy, the magnetizable particles and the balls into a unified structure. When the assembly has cooled, it may be used as an abrasive tool.

Thus, Oliver discloses a technique for preparing an abrasive tool which requires placement of protrusions on the external surface of a tool blank. These protrusions are the necessary surface for the formation of the conical structures of particles. The protrusions may take the form of small steel balls (as described) or shapes formed by machining a profile in the external surface of the tool blank. In either case, the tool blank which is the foundation of the ultimate product must be covered with protrusions. The small steel balls are expensive and require substantial labor to apply. If the protrusions are produced by machining a profile in the external surface of the tool blank, substantial skill and specialized equipment must be used.

Further, to apply carbide particles to protrusions located on a cylindrical structure, the structure must be fixtured and indexed to various rotary positions while the magnetizable carbide particles are applied. Preparing a tool in this manner is very complicated and prone to quality irregularities due to the variety of magnetic and gravitation forces which may be acting on the particles located in different rotary positions about the structure.

Further, the carbide particles form structures which align with the magnetic flux emanating from the magnetized tool blank. In the case of a cylindrical structure, the cones align

with magnetic flux emanating radially (or perpendicular to a tangent drawn to the surface) from the circumferential portion of the wheel. The conical structures formed thereby will be symmetrical in all respects, and when used as a cutting tool will offer a negative rake angle to the workpiece. The Oliver technique is capable of producing only these symmetrical conical structures. If more aggressive rake angles are desired, the Oliver technique is not appropriate.

Finally, as with any cutting or abrading tool, heat produced during cutting and abrading is conducted from the point of contact between the tool and the workpiece into the structure of the tool. When using an Oliver-type tool, heat passes from the conical structures through small steel balls and into the tool blank. Since these balls are brazed to the tool blank, they offer little more than point contact and consequently present a substantial impediment to the flow of heat.

OBJECTS OF THIS INVENTION

Accordingly, it is an object of this invention to provide an abrasive tool which reduces the time of preparation and labor and material cost associated with placement of protrusions on a base tool structure.

It is a specific object of this invention to provide an abrasive tool with abrasive particle structures directly secured to the base tool structure to improve the heat conduction away from the abrasive particle structures.

It is another object of this invention to provide an abrasive tool with abrasive particle structures selectively offering negative, neutral or positive rake angle cutting points to the workpiece.

It is another object of this invention to provide a matrix which may be incorporated in a process for manufacturing an abrasive tool which meets the aforesaid objects and which minimizes the expense of manufacture.

Other objects, advantages and features of the present invention will become apparent upon reading the following detailed description and appended claims and upon reference to the accompanying drawings.

SUMMARY OF THE INVENTION

In accordance with one embodiment of this invention which achieves the foregoing objects, a fixture includes a generally planar magnetized base surface with protrusions formed thereon to form a dotted or patchwork or mosaic surface. The protrusions may be machined into the surface or applied to the surface in the form of small steel balls. A release mechanism or covering layer is then placed over the surface of the protrusions. The release mechanism may take the form of, for example, a thin coating of silicone or a thin sheet of polymeric material (such as Teflon). Next, magnetizable abrasive particles are diffused or sprinkled onto the surface of the release mechanism. The particles collect or orient themselves along the lines of magnetic flux to form stacks having generally triangular cross sections. The stacks have an element axis and a distal portion or working portion. The stacks define a working surface for a tool. If small steel balls are used, conical structures or cones will form at the locations of magnetic flux concentration through the balls. A coat of acrylic paint is then applied to the cones. The paint provides structural integrity to the cones. Prior to solidification of the paint, the cones may be shaped by passing a magnet near them. A magnet of opposite pole from the polarity of the base surface magnet will cause the cones to grow in height; whereas, an identically poled magnet will

cause the cones to flatten. This magnet may also be used to selectively orient the base surface magnetic field which emanates from the protrusions to cause a realignment of the cones. This technique is used to produce asymmetrical cones which offer neutral or positive rake angle cutting points on the working surface of the tool.

After the cones have been shaped and the paint has dried or solidified, a braze paste or fixing means consisting of a binder mixed with a braze alloy is applied to encapsulate the cones and form a structural interconnection or nonmagnetic flexible support web or matrix between the cones. The braze paste provides a support web which maintains the cones in preselected positions before brazing and the braze alloy joins the cones in a solid structure or pattern after brazing.

After the braze paste has dried or solidified, the entire matrix may be removed from the base fixture leaving the balls or other projections behind. This matrix may then be cut to any desired shape. The release mechanism may then be removed and the matrix may be secured to another base structure having a smooth surface by application of an acrylic adhesive. The acrylic adhesive may be brushed on the matrix or the base structure or in the alternative may be preinstalled and protected by a release liner. At this point, the assembly of matrix and base structure may be placed in a braze furnace and heated at the necessary brazing temperature. After the brazing process has been completed, the assembly will feature a high friction surface which may be used as an abrasive tool.

The advantages of the present invention are numerous. For one, the protrusions are secured to a reusable fixture. Consequently, it is not necessary to apply protrusions to the external surface of each tool. Therefore, resources may be applied to create an optimum mosaic or pattern of protrusions (verses the random pattern used in the Oliver technique) which will then create respectively positioned magnetic fields. A mosaic may be selected to address performance parameters ranging from material removal effectiveness to surface finish quality. In addition, a substantial manufacturing cost advantage may be realized by eliminating the material cost of the balls as well as the labor associated with installing the balls on each tool.

Second, since the matrix is prepared on the generally planar surface of the fixture, which may be oriented in a horizontal plane, the carbide particles are influenced by magnetic flux acting along a flux axis generally transverse to the mosaic surface, which is aligned with gravitational forces. Consequently, the complications and irregularities that are encountered when applying the particles directly to irregularly shaped tools is eliminated.

In addition, the structure of the stacks of the present invention may be altered to produce a selectable rake angle (i.e., negative, neutral or positive). That is, the present invention is suitable for preparation of symmetrical stacks. These stacks are prepared by using magnetic flux having a flux axis which is generally perpendicular or normal to the mosaic surface. If a neutral or positive rake angle is desired, stacks may be prepared by using a magnetic flux axis which is adjustable and determinable relative to the mosaic surface whereby the stack axis will have a predetermined rake angle relative to the surface. For example, a neutral rake angle cone will be formed if the magnetic field is oriented such that the apex of the cone is located over a perpendicular drawn to the base circle of the cone. A positive rake angle cone will be formed if the magnetic field is oriented so that the apex of the cone is located outside of a perpendicular drawn to the base circle of the cone. In practice, the

magnetic field may be selectively oriented by creating a distortion above the surface of the fixture by use of a selectively positioned magnet.

The flexibility to produce cones having a selectable rake angle constitutes a substantial performance advantage in that tools may be prepared to suit specific performance applications. That is, cones having a positive rake angle may be applied to tools used in applications requiring aggressive material removal; whereas, cones having a neutral rake angle may be used for abrasive applications requiring less material removal. Additionally, combinations of cone types may be applied to the surface of a tool so that portions of the tool may be used for aggressive material removal and other portions may be used for producing a desired surface finish. For example, the end or face portions of a cylindrically shaped wheel may be covered with cones having a positive rake angle to aggressively remove material; whereas, the circumferential surface portions may be covered with cones having a negative rake angle to achieve a desired surface finish.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will be apparent to those skilled in the art to which the invention relates from the following detailed description of the invention made with reference to the accompanying drawings in which:

FIG. 1 is a side view of the fixture used for preparing the present invention;

FIG. 2 is a cross sectional view of a portion of the fixture shown in FIG. 1 including a section of the matrix prepared according to the present invention;

FIG. 3 is a cross sectional view of a portion of a base structure having a matrix applied thereto;

FIG. 3A is an enlarged section of FIG. 3;

FIG. 4 is a cross sectional view of a portion of an abrading tool prepared according to the present invention;

FIG. 4A is an enlarged section of FIG. 4;

FIG. 5 is a cross sectional view of an abrading tool offering a negative rake angle to a workpiece;

FIG. 6 is a cross sectional view of an abrading tool offering a neutral rake angle to a workpiece;

FIG. 7 is a cross sectional view of an abrading tool offering a positive rake angle to a workpiece;

FIG. 8 is a side view with portions shown in cross section of a fixture used to prepare a matrix having structures featuring neutral rake angles;

FIG. 9 is an enlarged plan view of a high friction surface having a fine textured pattern on a first portion and a coarse textured pattern on a second which in combination produce a herringbone pattern;

FIG. 10 is an enlarged plan view of a high friction surface having carbide structures with neutral rake angles on a first portion and a second portion covered with carbide structures having a negative rake angle;

FIG. 11 is an enlarged plan view of a high friction surface prepared by placing a pattern of carbide structures on selected portions and leaving other portions void; and

FIG. 12 is a side view with portions shown in cross section illustrating an alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

The preferred embodiment of the present invention, as shown in FIG. 1, includes a fixture 10 comprising a perma-

permanent magnet **12** which is affixed to a first base structure or steel plate **14**. Plate **14** provides a magnetic gap between the magnet **12** and protrusions **16**. Consequently, the thickness of plate **14** is a parameter which may be adjusted until the ideal magnetic field strength is achieved. Maximum magnetic field strength is achieved if plate **14** is completely eliminated. Alternatively, the plate **14** may be non-magnetic which forms an air gap or non-magnetic gap between the magnet **12** and protrusions **16**. Magnet **12** is not necessarily fixed to plate **14** and may be in the form of an electromagnet, or the like.

A single layer of protrusions in the form of steel balls **16** are affixed by adhesive **20** to plate **14**. Any ferrous or ferro-magnetic structure may be used in lieu of balls; for example, cylindrical steel rods may be used. A release mechanism **18** is shown as a thin layer of nonferrous material such as a sheet or film of plastic, preferably Teflon. The release mechanism is placed over the upper surface of the balls **16**. A source of vacuum may be introduced to the region between the protrusions and the release mechanism **18** by providing suitable passageways (not shown). The vacuum will draw the release mechanism **18** into firm contact with the protrusions **16**. This completes the fixture upon which a matrix of braze paste and magnetically oriented abrasive particles may be prepared.

The matrix **22**, as shown in FIG. 2 is prepared by sprinkling or diffusing $-200/+325$ mesh tungsten carbide cobalt particles (not shown individually in this figure) onto the release mechanism **18**. The particles are attracted to balls **16** by the magnetic flux from magnet **12**. These particles will collect on the release mechanism **18** at the locations of magnetic field concentration formed by the individual steel balls **16**.

Therefore, the size, shape, location and arrangement of the balls **16** determines the pattern generated by the carbide particle collections. Larger diameter balls will provide magnetic field concentrations which are spaced farther apart. Thus, larger diameter balls may be used to produce a coarse textured surface. Specific sizes, shapes and arrangements of balls may be used to generate any desired pattern. For example, the balls may be oriented in a herringbone pattern to enhance chip elimination from the area of the tool/workpiece interface. In fact, channels may be created to provide well defined chip passageways by eliminating a respective line of balls. Alternatively, non-ferrous balls can be interspersed with steel balls **16** to alter the formation.

As the carbide particles are diffused onto the release mechanism **18**, they will form collections of triangular cross sectioned structures **24**. In the preferred embodiment of the present invention, the structures **24** will be conically shaped, hereinafter referred to as cones. When the cones have reached a desired height by addition of particles, they are sprayed with an acrylic paint. While the paint is still wet, the cones **24** may be shaped by passing a second magnet over the upper surface of the fixture. A second magnet **40** oriented to expose a pole opposite to that of the fixture magnet **12** is shown in FIG. 2. An oppositely poled magnet will cause the cones to grow in height; whereas, a matching poled magnet will cause the cones to flatten.

After the paint has dried or solidified, the cones are coated with a water based braze cement (not shown) which provides a protective layer isolating the acrylic paint which maintains the structural integrity of the cones from the solvent contained in the coating of braze paste **26** which is added after the braze cement. A water based cement consisting of one part Nicrobraz Cement Type S, a trademark of Wall Colmonoy Corporation, and two parts water is preferred.

Braze paste **26** is then added to encapsulate the cones. A braze paste consisting of a binder or cement, preferably 40 percent Nicrobraz Cement Grade Number 1000, a trademark of Wall Colmonoy Corporation, and a braze alloy, preferably 60 percent -325 mesh low melting point brazing filler metal. Any braze cement which dries or cures to a flexible structure will be satisfactory. Form **28** placed on the release mechanism **18** serves as the outer boundary to which the braze paste **26** will flow. The height of form **28** will define the thickness of the matrix.

The braze paste **26** cures or dries to provide a flexible matrix **22**. This matrix **22** and release mechanism **18** may then be removed from the fixture **10** as a viable structural entity. The matrix may be cut to any desired pattern. The release means **18** may then be removed from the matrix **22** by peeling it away. After the release mechanism **18** has been removed, the matrix **22** may be secured to a second base structure **30**, as shown in FIG. 3, by use of an acrylic based adhesive such as 3M Corporation 2 mil. High Tack Adhesive transfer tape. Any suitable adhesive or binder may be utilized. The transfer tape has a release liner which protects the adhesive until the matrix is applied to a base structure. The second base structure **30** is not necessarily steel or ferrous.

FIG. 3A is an enlarged section of FIG. 3 illustrating the matrix **22** consisting of tungsten carbide cobalt particles **32**, acrylic paint **31** and the braze paste **26**, which itself consists of braze metal **34** and cement **36**. After the matrix has been secured to the surface of the base structure **30**, the entire assembly may be placed in a braze furnace and heated to brazing conditions, that is, the necessary brazing temperature for the necessary time period. Any temperature between 1850° F. and 2150° F. for a time period of approximately 15 minutes is appropriate for a low melting point brazing filler metal. An atmosphere of pure dry hydrogen or a vacuum is recommended. A hold cycle of 30 minutes is recommended at 800° F. before elevating to braze temperature. The braze metal **34** will become molten and flow to form a mortar-like bond of metal **38** (as shown in FIG. 4A) which secures or joins the tungsten carbide cobalt particles **32** together individually and to the base structure **30**. Thus, after brazing, only the braze alloy remains as the binder has vaporized.

The final product, as shown in FIG. 4, is a base structure **30** which is armed with cones **24** which provide the abrading tool cutting points. The base structure may be a cylindrical shape (such as a grinding wheel or an end mill), a flat rectangular shape (such as a hand file), or a long thin shape (such as a saw blade).

A symmetrical cone **46** as shown in FIG. 5 will present a negative rake angle X with respect to the workpiece **48** and the base structure **30**. A negative rake angle is preferred in abrasive applications with low-rate material removal. A symmetrical cone **46** may be produced by the fixture described herein. FIG. 6 illustrates an asymmetric cone **46'** having a neutral rake angle Y . A neutral rake angle is preferred in moderate-rate material removal applications. FIG. 7 illustrates another asymmetric cone **46''** having a positive rake angle Z . A positive rake angle Z is preferred in aggressive-rate material removal applications.

These asymmetrical cones may be generated by using the fixture shown in FIG. 8. The fixture **52** comprises a permanent magnet **12**, secured to a steel plate **14**, having steel balls **16** secured thereto. The release mechanism **18** is then placed over the balls **16**. Carbide particles (not shown individually in this figure) are then sprinkled through diffuser **56** onto the release mechanism **18** to form cones **24** having generally

symmetrical shapes. (See portion I). The magnetic flux emanating from the steel balls located in portion II is distorted by the presence of second magnet 40" such that the lines of flux in portion II are no longer emanating perpendicular to the surface. Consequently, the cones located in portion II will align themselves with the distorted lines of flux. The individual cone shown located in portion II has a neutral rake angle. A positive rake angle is formed by locating magnet 40" farther to the right (in relation to this figure) from portion II. Acrylic paint is applied to the cones 24 located in portion II by applicator 54. Once the paint has dried or solidified, the cones will maintain the orientation produced by the distorted lines of flux.

The cones located in portion III are ready to be encapsulated with braze paste (not shown) as described previously. In actual operation, the magnet 40", paint application mechanism 54 and diffuser 56 will move with respect to the fixture 52 and thus prepare a continuous matrix of magnetically oriented carbide particles and braze paste.

FIG. 9 shows an abrasive surface prepared with a fine textured matrix of structures on a first half portion 100 and a coarse textured matrix on the second half portion 102. In addition, the individual matrices provide a herringbone pattern which facilitates conveyance of chips to each side as the abrasive surface is advanced relative to a workpiece in the direction of the arrow shown. The coarse and fine textured matrices are produced by selecting ball sizes which will produce the desired spacing between the individual carbide structures. The herringbone pattern is produced by a specific arrangement of balls on the fixture previously described and shown in FIG. 1.

FIG. 10 shows an abrasive surface prepared with a negative rake angle matrix placed on a first portion 104 and a neutral rake angle matrix placed on a second portion 106. The apex 105 of the conical structures is illustrated as a dot and the respective base circle 107 of the structures is shown as a circle. Such a technique may be utilized to create an abrasive wheel which may be used to cut and finish a workpiece. That is, a more aggressive rake angle cone (i.e., a cone having a neutral rake angle) may be used on the first portion advanced into the workpiece and a less aggressive rake angle cone (i.e., a cone having a negative rake angle) may be used on the second trailing portion to finish the surface of the workpiece. Thus in one advance of the abrasive wheel, two operations may be performed.

FIG. 11 shows an abrasive surface prepared having portions 108 thereof covered by a matrix and portions 110 left void to offer passageways facilitating the elimination of scrap from the tool/workpiece interface. An identical abrasive surface may be prepared by leaving out rows of protrusions on the fixture. That is, the matrix may be prepared as a continuous structure wherein selected rows of small steel balls 16 (as shown in FIG. 1) may be left void thereby producing passageways facilitating the elimination of scrap from the tool/workpiece interface. This eliminates the necessity to cut and patch together portions of the matrix to produce the voids.

Any combination and permutation of textures, patterns, voids, and rake angles may be embodied on any one surface to produce a tool which satisfies numerous performance criteria.

All embodiments of the present invention have been described using tungsten carbide cobalt abrasive particles as an example of a magnetizable particle. It is clearly within the scope of this invention to use any magnetizable particle. For example, diamonds coated with nickel may be used. Further,

the structures formed at the points of magnetic field concentrations formed by the protrusions may consist of a plurality of particles as hereinbefore described or in the alternative may comprise one particle per point. An example of such an application would be for use in preparing mono-layered diamond tools as described in U.S. Pat. No. 3,894,673.

In an alternative embodiment, the matrix is prepared by positioning the particles on a release mechanism using mechanical techniques and then encapsulating them in a braze paste. Several techniques may be used to position the particles including manually arranging the particles. Once the particles have been arranged, they may be encapsulated with braze paste to produce a brazable matrix. Another technique utilizes a stencil-like form having openings which provide locations for the particles. Once the particles have been placed in the openings of the form, the form can be removed leaving the particles in their respective positions to be encapsulated in braze paste. Alternatively, as shown in portion I of FIG. 12, a stencil-like form 200 constructed of a moulded braze paste having openings 202 at selected locations may be used. A release liner 203 having no openings is placed in abutting relation to form 200. In portion II of FIG. 12, individual particles 204 are shown placed in the openings 202. Additional braze paste 206 is added in portion III of FIG. 12 to encapsulate the particles and retain them in their respective openings. In this manner a braze matrix may be prepared which is suitable for use in preparing a mono-layered diamond tool.

It is further thought that the apparatus and method of the present invention and many of its intended advantages will be understood from the foregoing description and it will be apparent that various changes may be made in form, construction and arrangement of parts thereof without departing from the spirit and scope of the invention or sacrificing all of its material advantages; the form herein before described being merely a preferred or exemplary embodiment.

What is claimed is:

1. An apparatus for assembling and supporting a mosaic pattern of magnetizable particles on a supporting web, said apparatus comprising:

a base;

a plurality of magnetizable protrusions extending from said base to define a mosaic surface;

a support sheet overlying said mosaic surface for supporting such magnetizable particles isolated from said protrusions but conforming to said mosaic pattern; and said support sheet providing a release surface for receiving and releasing said particles and supporting web from said support sheet while maintaining said mosaic pattern.

2. The apparatus of claim 1 wherein said mosaic surface is generally planar.

3. The apparatus of claim 1 wherein said base is of magnetizable material and underlies said protrusions.

4. The apparatus of claim 1 wherein said protrusions include ball members of a generally spherical shape.

5. The apparatus of claim 1 wherein said protrusions include rods of a generally cylindrical shape.

6. The apparatus of claim 1 including a magnetic flux source having a flux pattern generally transverse to said mosaic surface.

7. The apparatus of claim 6 wherein said flux is generally perpendicular to said mosaic surface.

8. The apparatus of claim 7 wherein said magnetizable particles become oriented in stacks having axes transverse to

said surface, said stacks having distal portions defining a working surface.

9. The apparatus of claim 8 wherein said flux pattern is adjustable and determinable relative to said mosaic surface whereby said stack axes will have a preset rake angle relative to said mosaic surface.

10. The apparatus of claim 6 wherein said magnetic flux source forms a portion of said base.

11. The apparatus of claim 1 wherein said mosaic surface has non-magnetic areas interspersed between said magnetizable protrusions.

12. The apparatus of claim 11 wherein said base is disposed between said magnetic flux source and said magnetizable protrusion means.

13. The apparatus of claim 1 wherein said base is of adjustable thickness.

14. The apparatus of claim 1 wherein said sheet is a film of polymer material.

15. The apparatus of claim 1 wherein said magnetizable protrusions form a portion of said base.

16. The apparatus of claim 1 wherein said magnetizable protrusions define a space between said base and said support sheet and the apparatus includes means for establishing a partial vacuum condition in said space.

17. An apparatus for preparing a matrix of magnetizable particles, said matrix including binding means, said magnetizable particles being at least partially encapsulated in a mosaic pattern with said binding means comprising:

a plurality of magnetizable protrusion members;

base means for supporting said protrusion members to define a mosaic surface;

a magnetic flux source having a flux pattern through said protrusion members; and

a support sheet covering said mosaic surface for supporting said matrix isolated from said protrusions, said support sheet providing a release surface for receiving and releasing said matrix from said support sheet while maintaining said mosaic pattern.

18. The apparatus of claim 17 wherein said mosaic surface is generally planar.

19. The apparatus of claim 17 wherein said base means is of magnetizable material.

20. The apparatus of claim 17 wherein said protrusion members include ball members of generally spherical shape.

21. The apparatus of claim 17 wherein said flux pattern is generally perpendicular to said mosaic surface.

22. The apparatus of claim 17 wherein said magnetizable particles become oriented in stacks having axes transverse to said surface, said stacks having distal portions defining a working surface.

23. The apparatus of claim 22 wherein said flux pattern is adjustable and determinable relative to said mosaic surface whereby said stack axes will have a preset rake angle relative to said mosaic surface.

24. The apparatus of claim 17 wherein said support sheet is a film of polymeric material.

25. The apparatus of claim 17 wherein said binding means is a mixture of braze alloy and a binder.

26. An apparatus for assembling magnetizable particles in a matrix comprising:

base member;

a plurality of magnetizable protrusion members defining a first surface spaced from said base member, said base member including means for generating a magnetic flux;

a film of polymeric material disposed on said first surface; and

means for establishing a partial vacuum condition between said polymeric material and said first surface, said vacuum condition holding said polymeric material in contact with said magnetizable protrusion members to receive said matrix of magnetically oriented particles.

27. An apparatus for assembling and supporting a mosaic pattern of magnetizable particles on a support web, said apparatus comprising:

a plurality of magnetizable protrusions aligned in side by side relationship to define a mosaic surface;

a sheet overlying said mosaic surface and defining a support surface which has a releasing characteristic relative to said magnetic particles and said support web; and

a magnetic flux generating source having a flux pattern generally transverse to said mosaic surface, said sheet being disposed between said support web and said magnetizable protrusions.

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